A View Among the State Buildings at the San Diego Exposition

The Sectionalizing of Electric Railway Feeders at San Diego

Sectionalizing Switches Adequately Handle Conditions that Otherwise Would Call for a 30 Per Cent Increase in Copper Over Present Use

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THE overhead system of the San Diego Electric Railway, consisting of feeders and trolley, differs considerably from most street railways inasmuch as under normal working conditions the sections are connected together all over the system with automatic sectionalizing switches. The feeders, in consequence, all operate in multiple as shown in the accompanying drawing of trolley sections. The switches are automatic in the sense that they are controlled from the switchboard. At the power station, the feeders to the different lines are mounted on separate panels through switches and breakers in the usual manner, but in case of accident or ground, any section may be cut out by opening the feeder breakers. It is not necessary in any case when it is desired to cut power off of any section to send a man out to pull switches, and as soon as the trouble has been cleared, the operator puts the section back on the line, thereby closing such sectionalizing switches as may be connected with it.

The first part of the San Diego installation was made in 1911 when eleven General Electric switches were installed. They worked out so satisfactorily that in making additions last year five more were installed. Nine of the switches are located within a radius of 1 mile of the power station, and during the five years of application not a single switch was lost. Further, the total amount for repairs during this period has been less than $25.

As the feeders work in multiple, the peak demand is divided among several feeders and the maximum current on any one is much less than if all the current for that one section was delivered over but one feeder. The result is a comparatively steady load on each feeder out of the power station with each feeder designed for that steady load which is less than maximum. To obtain the same voltage conditions without the use of these sectionalizing switches, an increase in copper of about 30 per cent would be required.

When a "short" occurs on the line, all, or nearly all, of the breakers go out. This is considered an advantage rather than a disadvantage because the total current is divided among many breakers, while without the sectionalizing switches one feeder breaker must open the circuit with the consequent

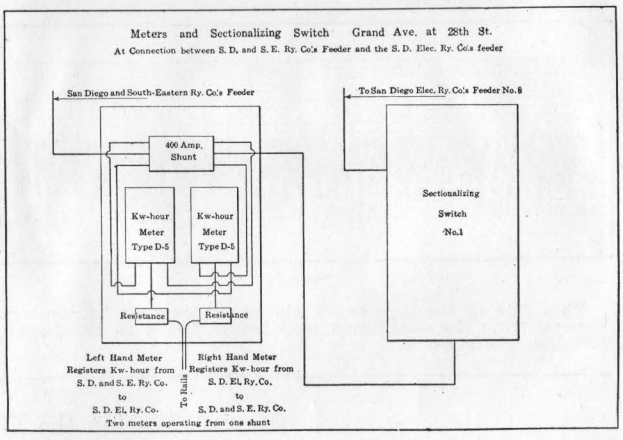

Diagram Showing Connection for Kilowatt-Hour Meters and Sectionalizing Switches

RECORD AT SECTIONALIZING SWITCH NO. 1

Twenty-eighth Street and Grand Avenue
Feb. 15, 1915

Taken before installing the 500,000 circ. mil additional feeder on Section No. 7, from power station to Sixteenth and M Streets.

This side of the zero mark shows the current in amperes flowing from the San Diego & South Eastern Railway Company's feeder to the San Diego Railway Company's Logan Heights feeder No. 8.

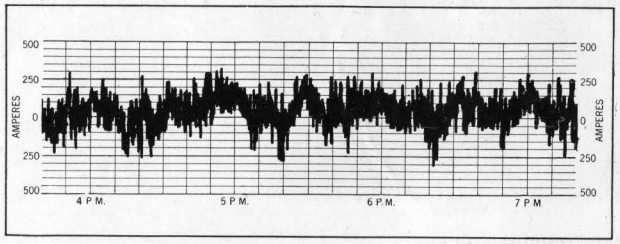

Fig. 1

This side of the zero mark shows the current in amperes flowing from the San Diego Electric Railway Company's Logan Heights feeder No. 8 to the San Diego & South Eastern Railway Company's feeder.

RECORD AT SECTIONALIZING SWITCH NO. 2

Sixteenth and M Streets
March 26, 1915

Taken before installing the 500,000 circ. mil additional feeder on Section No. 7, from the power station to Sixteenth and M Streets.

This side of the zero mark shows current in amperes flowing from the Logan Heights feeder No. 8 to M Street feeder No. 7.

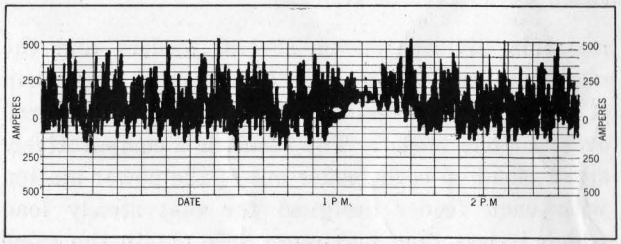

Fig. 3

This side of the zero mark shows the current in amperes flowing from the M Street feeder No. 7 to the Logan Heights feeder No. 8.

RECORD AT SECTIONALIZING SWITCH NO. 3

Fifth and Market Streets
Feb. 1, 1913

Taken before installing an additional 500,000 circ. mil feeder on Section No. 7, from the power station to Sixteenth and M Streets.

This side of the zero mark shows the current in amperes flowing from the Logan Heights feeder No. 8 to the downtown loop feeder No. 6.

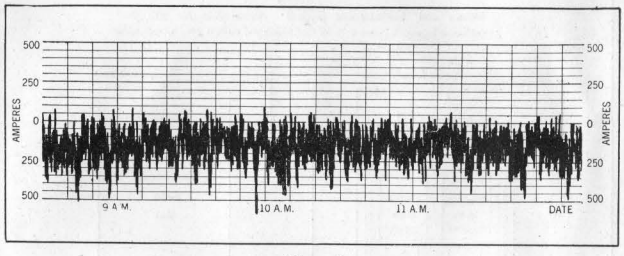

Fig. 5

This side of the zero mark shows the current in amperes flowing from the downtown loop feeder No. 6 to the Logan Heights feeder No. 8.

RECORD AT SECTIONALIZING SWITCH NO. 1

Twenty-eighth Street and Grand Avenue
July 19, 1915

Taken after installing the 500,000 circ. mil feeder on Section No. 7, from the power station to Sixteenth and M Streets.

This side of the zero mark shows the current in amperes flowing from the San Diego & South Eastern Railway Company's feeder to the San Diego Electric Railway Company's Logan Heights feeder No. 8.

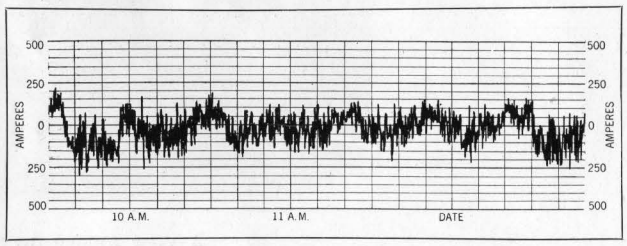

Fig. 2

This side of the zero mark shows the current in amperes flowing from the San Diego Electric Railway Company's feeder No. 8 to the San Diego & South Eastern Railway Company's feeder.

RECORD AT SECTIONALIZING SWITCH NO. 2

Sixteenth and M Streets
July 13, 1915

Taken after installing the 500,000 circ. mil feeder on Section No. 7, from power station to Sixteenth and M Streets.

This side of the zero mark shows the current in amperes flowing from the Logan Heights feeder No. 8 to the M Street feeder No. 7.

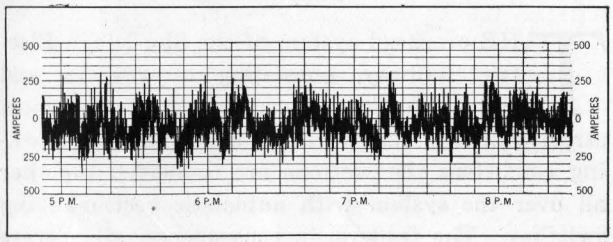

Fig. 4

This side of the zero mark shows current in amperes flowing from the M Street feeder No. 7 to the Logan Heights feeder No. 8.

RECORD AT SECTIONALIZING SWITCH NO. 3

Fifth and Market Streets
July 10, 1915

Taken after installing an additional 500,000 circ. mil feeder on Section No. 7, from the power station to Sixteenth and M Streets.

This side of the zero mark shows the current in amperes flowing from the Logan Heights feeder No. 8 to the downtown loop feeder No. 6.

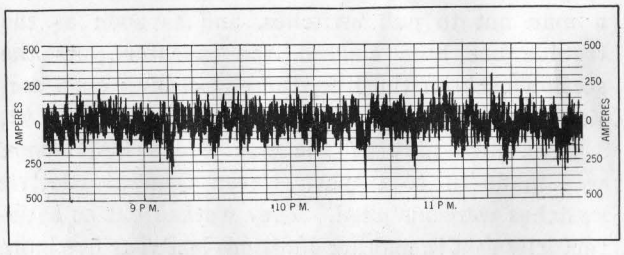

Fig. 6

This side of the zero mark shows the current in amperes flowing from the downtown loop feeder No. 6 to the Logan Heights feeder No. 8.

Graphs Showing the Flow of Current in Feeders Before and After Sectionalizing the San Diego System

burning. During the period this system has been used not a single breaker has been burned or put out of service.

With this system, the current delivered from the power station to any point on any feeder is simply proportional to the resistance. Should the resistances of the two feeders from a switch to the power station be equal, the average current through the switch will be zero, but if the resistances are unequal, the exchange will be all in one direction through the switch, the feeder with the lower resistance delivering the most current. The following example shows the effect of adding copper to one of several feeders operating together:

An additional 500,000 circ. mil. feeder was recently installed on Section No. 7, from the power station to Sixteenth and M Streets and records of the exchange of current through the sectionalizing switches Nos. 1, 2 and 3 were taken, before and after installing, by means of a General Electric Type C-5, curve-drawing ammeter, the zero of which is on the center of the scale. An examination of Figs. 1 and 2 shows that the installation of the additional feeder has made the average exchange of current at switch No. 3 practically zero instead of being about 175 amp. from the loop feeder No. 6 to the Logan Heights feeder No. 8. In other words, this load of 175 amp. has been shifted from feeder No. 6 to feeder No. 8. Similarly, Figs. 3 and 4 show how much the exchange current at switch No. 2 has been reduced and the load demanded by feeder No. 7 carried by the new feeder instead of being obtained from feeder No. 8. Going to switch No. 1, Figs. 5 and 6 show that feeder No. 8 now is in condition to deliver current to the San Diego & South Eastern Railway instead of demanding current from the San Diego & South Eastern Railway, as is seen by the charts.

The San Diego Electric Railway has extended this system to interurban and suburban lines which are customers and take 600 volts direct current direct from the power station. The benefit is mutual as it not only gives the customer additional capacity and better voltage, but gives the city lines the advantage of such copper as is in place on the customers' lines. An accompanying diagram shows the interchange of current between the San Diego Electric Railway Company and the San Diego & South Eastern Railway Company's feeders at switch No. 1. In general, the chart shows that this customer demands more current through this switch from the city lines than the city lines demand from the customer. At such points of connection it is necessary to install, beside the sectionalizing switch, two kilowatt-hour meters. One of these meters registers the energy transferred from the customer to the city lines and the other registers the energy transferred from the city lines to the customer. Each meter is arranged with a detent to prevent it from running backward when the current reverses. The difference between the amounts of power transferred in each direction is the net transfer in one direction. Should this net transfer be in favor of the customer, it is added to his monthly bill; but is subtracted if it is in favor of the city lines. Another drawing shows the connections of these kilowatt-hour meters and the sectionalizing switch with the feeders at Grand Avenue and Twenty-eighth Street. Such connections are made as far from the power station as possible.

The Calle Cristobal, San Diego Exposition. Street Lights Illuminating the Building Fronts